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MANPRINT-Related Research for the Imagery Intelligence Area

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This investigation addresses the need to identify potential MANPRINT-related research issues in the Army Imagery Intelligence (IMINT) Area and develop a research plan for studying those issues.

Potential research issues were identified through the review of documents related to imagery intelligence and corps-level doctrine and through interviews with functional subject matter experts (SMEs) in the intelligence community.

Following the identification of potential research issues, the authors developed a research strategy to address the issues and a plan for a research demonstration in an imagery intelligence field exercise.

The literature review and interviews with SMEs identified a number of MANPRINT-related issues. The issues were grouped into five categories of MANPRINT-related topics: (1) Manpower and Personnel; (2) Training; (3) Human Factors/Health Hazards; (4) Organizational Structure; and (5) Requirements Analysis. A sixth category, engineering and facilities, impacts on many of the MANPRINT-related factors. (Continued)

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--> The IMINT MANPRINT-related issues and the research strategy identified in this effort provide a foundation for building a research program that supports decision makers in the intelligence community.

MANPRINT (Manpower and Personnel Integration;
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MANPRINT-RELATED RESEARCH FOR THE IMAGERY INTELLIGENCE AREA

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MANPRINT-RELATED RESEARCH FOR THE IMAGERY INTELLIGENCE AREA

SECTION 1: INTRODUCTION

Objective

The primary objectives in the current research effort were to identify MANPRINT-related research issues in the Army Imagery Intelligence (IMINT) area.

Background

MANPRINT (Manpower and Personnel Integration) is an Army initiative designed to facilitate the early consideration of constraints placed upon system operability and supportability by the human performance factors. In addition to manpower, personnel, and training (MPT) factors, MANPRINT includes the evaluation of issues in the human factors engineering, safety, and health hazards domains. The Army's focus on MANPRINT is a direct result of serious problems faced by the Army and other military services in fielding large numbers of new systems. Unless the MANPRINT domains are considered early in the system development process, there is a high probability that human performance problems will seriously degrade anticipated system effectiveness when the system is introduced to the field.

Research to determine MANPRINT impacts on system performance has become increasingly important due to the effects and interactions of a number of variables. First, the Army plans to field over 400 new systems in the foreseeable future. Many of the new systems include applications of "high technology" which create a superior system that is complex to operate and difficult to maintain. The complex systems place increased demands on personnel and create the need for personnel with different combinations of skills than those currently recruited for and/or trained. The increased demands for skilled personnel are occurring at a time when population demographics indicate a shrinking manpower pool from which to recruit. The interaction of the high technology systems with a static or shrinking manpower base creates increased demands for training.

The IMINT area exemplifies many of the characteristics described above. The state-of-the-art in IMINT collection and exploitation is currently in a rapid state of transition. A number of new, high technology systems will be fielded in the near future. It is widely recognized that the demands on imagery interpreters are likely to change with the fielding of the new systems and a number of unanswered questions exist

regarding human performance factors which might impact on the effectiveness of the imagery analysis process.

The U.S. Army Research Institute (ARI) has been actively involved in the development of MANPRINT concepts and applications technology since the inception of the Army's MANPRINT initiative. The current research effort represents the initial step in extending ongoing MANPRINT research programs into the intelligence functional area. The extension of the MANPRINT program includes an expansion of the MANPRINT concept from a focus on single systems/units to consideration of MPT factors related to technology changes in a major functional area within the Army. This initial MANPRINT initiative in the IMINT area was incorporated in ongoing research programs supporting the U.S. Army Intelligence Center and School (USAICS), Fort Huachuca, Arizona.

Scope

As an initial effort in the investigation of MANPRINT issues in the IMINT area, the current effort had a relatively modest set of objectives and scope. The initial focus of the project was to identify MANPRINT-related issues which might be addressed by future ARI research. The objective of the current research effort was modified to identify MANPRINT-related issues which could be studied in imagery field exercises.

Organization of the Report

The remainder of the report describes the approach and findings of the research project. Section 2 describes the research approach and sources of information used to identify relevant research issues. Section 3 provides a detailed discussion of MANPRINT-related issues identified in the IMINT area. Section 4 provides a research strategy which could be implemented to study the MANPRINT issues in IMINT field exercises. The discussion of the research strategy includes both long- and short-term research objectives and projects.

SECTION 2: RESEARCH APPROACH

Introduction

The approach employed in the current effort was designed to identify MANPRINT research issues in the IMINT area. The research approach included three major elements. The first two elements were literature reviews and interviews designed to

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identify potential MANPRINT research issues. The third element was an iterative analysis and synthesis of potential research issues which was achieved through brain-storming sessions and feedback from functional SMEs in the intelligence area. The paragraphs below describe each of the three components in the research process in more detail.

Literature Reviews

The primary source of potential MANPRINT research issues identified in the present study was the review of the literature in three related areas. The initial document reviewed in the project was the draft of the Army Imagery Plan. This is a classified document which presents a detailed evaluation of requirements and capabilities in various domains of the IMINT area. This document and related reference material was the source for the greatest number of IMINT-specific research issues. The review of the Army Imagery Plan suggested that documents possessed by the research team in the areas of Intelligence System and Organization Architecture and Corps-level Army Doctrine should also be included in the literature review.

A variety of classified documents related to intelligence system and organization design architecture were examined in the second literature review. The primary purpose of the review of these documents was to identify research issues related to organizational structure and imagery exploitation mission requirements which would impact on imagery manpower and personnel requirements.

A major finding from the review of the Army Imagery Plan and the Intelligence organizational architecture literature was that a variety of MANPRINT-related issues could be linked to imagery exploitation requirements at the corps-level. Furthermore, it appeared that change in the Army doctrine was a major factor impacting on changing intelligence requirements. To further examine the relationship between intelligence MANPRINT issues and doctrine a number of doctrinal publications were reviewed. These are also shown in the reference list.

The potential research issues identified in each of the three literature reviews were analyzed and categorized into a consolidated list. The categories into which the issues were sorted included MANPRINT-related domains of manpower and personnel, training, and human factors. Non-MANPRINT categories included organizational issues, requirements analysis issues, and engineering/facilities issues. The decision was made to limit issues to those categories relevant to the ARI research charter. As a result of this decision, the engineering/ facilities category were dropped from further consideration in

the study. The organizational issues and requirements analysis issues, while not directly related to traditional MANPRINT domains, clearly impacted on the the MPT domains and were maintained as potential research issues which might be investigated by ARI.

Input from Functional Area SMEs

Following the initial literature reviews, input was obtained from functional area SMEs in the IMINT area. The SME input was obtained through interviews with individuals from the office of the Assistant Chief of Staff for Intelligence (ACSI), the Office of the Secretary of Defense (OSD), and USAICS. The interviews varied in length but the primary focus in each was the identification of potential research issues in the IMINT Area which are related to MANPRINT.

Analysis and Synthesis of Potential Research Issues

In addition to the individual interviews with SMEs, the research team conducted several briefings and information exchange meetings with individuals and research teams working on related intelligence research efforts. The briefings and discussion sections served as a means to obtain feedback from the intelligence community on the importance and relevance of the

The feedback from the briefings and brain-storming sessions within the research team were the primary means for refining the list of potential research issues identified in the literature reviews and SME interviews. The information obtained from these sources was used as a final filter for eliminating potential MANPRINT-related research issues. The final list of potential MANPRINT-related research issues was prioritized based on input received from the functional area SMEs and the ARI COR.

SECTION 3: RESEARCH FINDINGS

General

Before presenting the specific research issues identified in the current effort, it is important to discuss some general findings which provide a context from which to view the specific MANPRINT-related issues. These general findings are related to the role of IMINT in military operations and the impact of changes in operational doctrine on intelligence requirements.

The Role of Imagery Intelligence in Military Operations

IMINT is a relatively new intelligence area which appears to have an increasingly important role in supporting the planning and execution of military operations. While IMINT has been used extensively since WWII, the introduction of a variety of platforms and high technology collection and exploitation systems has dramatically increased the amount and quality of the imagery data available to support Army commanders. The various ways in which IMINT data are used to support the planning and execution of operations are described briefly in the paragraphs below.

Battle Management. The demands for hardcopy imagery appears to be increasing at all organizational levels. Commanders find the hardcopy imagery to be a highly credible source of data which can be used by their G-2 and G-3 (Intelligence and Operations) staffs for situation assessment in development of operations plans and orders. Commanders have a high level of confidence in the hardcopy imagery data. A key aspect of the use of the imagery data in the battle management process is in the intelligence preparation of the battlefield (IPB) process. Hardcopy data is used to examine the terrain features and identify the locations and disposition of friendly and enemy forces.

Maneuver Support. Hardcopy imagery is used in a number of different ways to directly support the planning and execution of maneuvers. The Army Imagery Plan (1985) notes that imagery is used as a map substitute in both planning and land navigation applications. Since the hardcopy imagery data often reflects the latest road and bridge damage, it is commonly used for planning maneuver routes. Hardcopy imagery was identified as particularly important for the planning of amphibious landings and maneuvers against highly fortified positions.

Target Selection and Analysis. Imagery is particularly important in the planning of indirect fire support and air support missions. Imagery is used for both target location and analysis. With increased emphasis on fighting the "deep battle" at the corps-level, there has been a corresponding increase in the demands for imagery data which will allow deep target identification and analysis within the Corps Area of Influence.

Impact Analysis. The increased emphasis on the Army's role in fighting the deep battle has also increased the need for Army commanders at the division and corps-levels to assess the impact of air and artillery strikes on deep targets. Since deep targets are normally beyond the range of assessment allowed by ground-based recon elements, imagery data from air platforms is the primary means for post attack/strike assessment.

Impact of Doctrine on Intelligence Requirements

As indicated from the discussion of operational doctrine related to the fighting of the deep battle, changes in doctrine impact on intelligence requirements. In fact, it is important to note that operations requirements are the primary driver of intelligence requirements. As noted in FM 100-5, Operations, (1986) the AirLand Battle doctrine presented in the manual is based on the view that the modern battlefield will be a highly fluid, chaotic setting with no clearly delineated front and rear areas. The doctrine suggests that commanders must be increasingly concerned about fighting battles in depth and must have the information required to "see the battle" in depth and make rapid adjustments to their plans.

Both FM 100-5 and FC 100-15, Corps Operations, (1984) emphasize that the corps plays a major role in the synchronization of close-in, deep, and rear operations on the modern battlefield. The corps is also the focal point for fighting of the deep battle and synchronization of operations across the armed forces. A primary factor for the emphasis on the corps in Air-Land Battle doctrine is the fact that the corps represents the interface between tactical and strategic levels of warfighting making it an operational level organization. Airland Battle doctrine is primarily an operational level doctrine and thus is particularly relevant for corps operations. The doctrine also targets the corps level as the critical point for collection management and integration of intelligence data needed to fight the deep battle. The corps is also identified as uniquely qualified for integrating intelligence data from national sources, other Services, and tactical ground units.

Corps Synchronization Demands. The focus on the corps-level which is present in Air-Land Battle doctrine may be one of the factors driving current debates concerning the need for various types of imagery data at the corps-level vs. echelons above corps (EAC). The synchronization of operations which doctrine dictates should take place at the corps-level requires considerable intelligence data which is exploited in a very timely manner. It is not surprising that corps commanders feel the need to have maximum control over the collection and exploitation assets which provide the intelligence information (particularly imagery) required to synchronize large-scale operations and fight the deep battle. This operational demand, in turn, creates issues related to the organization and placement of limited IMINT equipment and personnel.

Summary

Future changes in operational doctrine are likely to have similar effects on intelligence requirements. While the exact

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nature of these effects cannot be anticipated, it is important for the reader to recognize that the MANPRINT-related research issues to be discussed in the remaining sections of this section of the report, do not exist in a vacuum. The demands on manpower, personnel, and training are a function of many factors, including doctrine, not just a result of the characteristics of IMINT systems which currently exist or which will be fielded in the future.

Potential MANPRINT-Related Issues

A detailed discussion of potential research issues in the areas of manpower and personnel, training, human factors, organizational structure, and intelligence requirements analysis methodology are presented below. A sample of the engineering/ facilities issues identified during the study is also presented. Appendix A provides a comprehensive listing of the potential research issues identified in the study. It is important to note that while the potential research issues are discussed in different categories, many of the issues are highly interrelated. The collection of data on a single issue in the manpower area without regard for related issues in the training or requirements areas, for example, is likely to provide results with limited utility. It is quite possible that research based on data collected to examine a single issue may provide a misleading impression of the true nature of the MANPRINT situation in the IMINT area. This problem will be discussed in greater detail in Section 4 of the report.

Manpower and Personnel Issues

The draft of the Army Imagery Plan placed relatively little emphasis on manpower and personnel issues. For the most part, the plan indicated that adequate manpower was available for imagery requirements and that personnel had the skills required to perform required imagery missions. The plan did note that the authorization of positions in MOS 96D (Imagery Analyst) for corps support elements had been increased as a result of increased emphasis on IMINT. The only major issue identified in the manpower and personnel areas was related to personnel management. The plan suggested that additional skill indicators were needed to allow easier identification and management of personnel qualified to operate some of the newer imagery systems such as the IPDS.

The interviews with SMEs from OSD and USAICS presented a somewhat different picture concerning potential research issues in the manpower and personnel areas. SMEs from OSD anticipate significant manpower planning problems resulting from the fielding of a large number of imagery systems across the

different military services. Research efforts are currently underway within OSD to establish baseline data, project manpower requirements, and develop manpower planning models for the intelligence functional area. The SME who was interviewed from USAICS had similar concerns regarding manpower and organizational structure issues. A major issue requiring research identified by the USAICS SME was the manpower requirements for performing imagery exploitation on new systems at different organizational levels in the Army. In addition, this SME was concerned about changing personnel skill requirements created by the transition from hardcopy imagery exploitation to softcopy exploitation which will be made possible by systems entering the field in the near future. Research related to appropriate MOS structure in the imagery area is one example of the type of MANPRINT research required.

Training Issues

The Army Imagery Plan and interviews with the SMEs were consistent in identifying a number of training issues as potential MANPRINT research topics. The key issue identified in the Army Imagery Plan is the increased training burden being created by new imagery systems being fielded by the Army. The plan specifically noted the MAGIIC (Mobile Army Ground Imagery Interpretation Center), the DITB, the TREDS (Tactical Reconnaissance Exploitation Demonstration System), the TacIES (Tactical Imagery Exploitation System) and the ETUT (Enhance Tactical Users Terminal) as examples of the systems which presented training problems for the imagery area. The crux of the problem is that, while it is not cost-effective to conduct resident, system specific training for the new systems, time constraints and lack of expertise in the field hinder the effective use of on-the-job training in units. This is one of the primary issues which MANPRINT research typically addresses for new systems.

A related research issue in the training area identified in the Army Imagery plan is the need to examine the use of embedded training and on-line job-aids as a substitute or supplement to system specific training. The fact that many of the new systems are highly computerized and operated using CRTs increases the opportunity for taking advantage of such alternatives. The major research issues surrounding this training/performance issue deal with the optimal format and content for embedded training and effective means for implementing job-aids in the system.

In addition t training requirements generated by the fielding of new systems, changes in doctrine are also generating new training requirements in the imagery area. While not prohibitive in and of themselves, the training burden created by

doctrinal changes interact with and conflict with demands for training created by the fielding of new systems.

A major training issue for the IMINT area concerns the management of training for the Reserve Component. The nature of the imagery interpretation process makes it difficult for an imagery interpreter to "come up to speed" when he is deployed to a new geographical location. This increases the difficulties which are typically associated with training Reserve Component members in general. The fact that most imagery interpretation training must be conducted in Special Compartmented Information Facilities (SCIFs) further exacerbates the problem. This requirement for compartmented training also creates interdependencies between requirements for new facilities and availability of training for the reserve component. Similar relationships between shortage of facilities and ability to conduct training were noted for resident training at USAICS.

The increased rate of fielding new systems also interacts with the Reserve Component training issue. As the number of new systems fielded increases, the gap in skills between reserve and active component members increases creating the potential for serious manpower problems if a major deployment is required.

A partial solution to the reserve component training issue and to the training burden created by the fielding of new systems is the development of realistic imagery interpretation simulations which could be run on micro-computers. Considerable research is required to develop the simulations as well as to assess the potential effectiveness of this alternatives for solving training problems. Realistic simulation would require classified data and create a number of issues related to TEMPESTED computer systems and need for the systems to be secured in SCIFs. These related issues would need be included in the MANPRINT research effort examining potential impact of the fielding of imagery interpretation simulations.

The final major training issue identified in the Army Imagery Plan and discussed by the SME from USAICS is the design and evaluation of a generic IMINT training program. The concept for the program titled FSIT (Full Spectrum Imagery Training) has been developed by USAICS. A number of research issues concerning identification of generic imagery interpretation tasks on new systems and MOS training requirements must be examined to evaluate the concept.

USAICS has also identified the need to examine the relationship between changes in personnel skills and changes in basic approaches to training imagery interpreters. It is not clear whether changing skill requirements on new systems could be best met by recruiting imagery interpreters with different expertise and academic backgrounds or by changing the structure

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and content of current training programs. A comprehensive MANPRINT related research effort will be required to generate the data required to conduct the necessary trade-off analyses to answer such questions.

Human Factors and Health Hazards Issues

The final category of potential issues which fall within the traditional MANPRINT domains are a limited number of issues which fall into the human engineering/health hazards arena. These issues were identified in discussions with the USAICS SMEs and the imagery field exercise planning group. The research issues focus on potential problems which may arise in the transition from hardcopy to softcopy imagery exploitation in the Army. The discussions indicate the potential need for research to identify human factors data related to length of time which imagery interpreters can be expected to maintain high vigilance levels while using CRTs. It is recognized that the imagery interpreters will work under stressful conditions during wartime and that mistakes made by an interpreter may produce severe negative consequences, thus contributing to the stress. In addition to such cognitive stress factors, there is a need to examine physical demands related to visual activity required in soft-copy imagery exploitation for extended time periods. The human factor and potential health hazard issues must be considered in the design of SCIFs in which the imagery exploitation will take place.

Organizational Structure Issues

A set of potential research issues which are closely related to manpower planning and directly impact on manpower allocation are those categorized under the organizational structure heading. A number of organizational issues were identified in the Army Imagery Plan as well as in the discussions with the SMEs from OSD. Two major issues of concern in this area concern the degree to which imagery assets should be centralized and the level at which centralization should occur. As noted earlier, the primary focus of these organizational issues is on imagery exploitation at the corps and EAC levels. The Army Imagery Plan reviews the pros and cons of each alternative. The ability to make the optimal choice in the centralization vs. decentralization issue is at least partially hampered by the lack of valid data on documented functional requirements for imagery exploitation at various organizational levels within the Army. The nature of the requirements for imagery exploitation is probably in a state of transition given the recent changes in doctrine at the corps level. This issue will be discussed in more detail shortly. Other factors which must be considered in examining the centralization issue concern the demands placed

upon communication and information processing channels by a highly centralized imagery processing approach at EAC.

In addition to the major issue of centralization vs. decentralization of imagery assets including manpower, the Army Imagery Plan also identified the need for evaluation of the structure of current CEWI (Combat Electronic Warfare and Intelligence) organizations at division and corps levels. The organization of various Reserve Component were also raised as an issue although it did not appear to be a potential research issue as much as an administrative issue.

The final organizational issue raised in the Army Imagery Plan and other documents reviewed by the research team relates to the proper organization of the collection management process. This includes relationships between intelligence and operations sides of the organization and questions related to control of collection assets. As noted earlier in the discussion of changes in operational doctrine, the *corps commander* has a significant intelligence data requirement. During an interview with an ex-corps commander conducted as part of another research effort, the issue of control of IMINT collection assets was raised as one of the individual's concerns when he was a corps commander. He felt that he had been given an intelligence mission without control of the assets required to complete the mission in support of his requirement to fight and synchronize the deep battle.

Requirements Analysis Issues

The research issues presented in the discussions above were all explicitly identified in the documents reviewed or mentioned in the discussions with the SMEs. Underlying a number of the issues identified in the documents and in discussions with SMEs is another set of potential research issues. This category of issues is related to the problem of assessing intelligence requirements. The Army Imagery Plan devotes considerable time to a discussion of imagery requirements and resources for each of the corps in the Army. It must be noted, however, that imagery requirements are calculated based on targeting counting estimations and algorithms for estimating imagery frames required for target coverage. This requirements analysis methodology is strictly an engineering approach which allows no assessment of actual functional requirements for different types of imagery data nor any assessment of the exploitation requirements for the data. While the data generated by the current requirements methodology may allow assessment of the collection and hardcopy processing equipment required to produce the "required" frames of imagery, it will not allow any assessment of manpower and personnel requirements for the imagery exploitation process.

The Army Imagery Plan clearly notes the role of IMINT in operational planning and battle management. However, only one of the organizations surveyed to collect data for the plan attempted to relate intelligence requirements to its needs in support of operations. The remaining imagery requirements analyses are related strictly to potential targets and equipment/system coverage.

The analyses of manpower, personnel, and training requirements as well as consideration of the organizational issues identified in the plan would all benefit from the development of a requirements analysis methodology. The methodology must be focused on identification of IMINT requirements as a function of operational planning and battle management needs at different organizational levels. As noted in FC 100-15-1, Corps Deep Operations (1985), the timeliness, quality, quantity, and detail of intelligence data vary considerably during different phases of corps level operations. Efforts must be made to more clearly delineate what these differences are, the factors related to different intelligence requirements, and how the factors change across organizational levels.

Closely related to development of a requirements analysis methodology is another potential research issue which concerns assessment of effectiveness of the imagery analysis process. The effectiveness of the process must be related to the original operational requirements. Once a requirements analysis methodology has been developed, it will be possible to develop an imagery analysis performance model. The development of such a model will provide the basis for constructing analytic MANPRINT tools and data collection instruments which can be used to assess manpower, personnel, and training requirements as well as assessment of the effectiveness of training programs.

Engineering and Facilities Issues

All of the issues described above represent potential research issues relevant to the U.S. Army Research Institute. The Army Imagery Plan also identified a number of issues which are probably not within the normal scope of research conducted by ARI. In the paragraphs below, the authors will briefly discuss the nature of some of these issues presented in the Army Imagery Plan. While such issues may not be appropriate research topics for ARI, they do impact on other areas such as training. Researchers at ARI should be cognizant of these issues to the extent that they impact on the nature and outcome of the phenomena of interest to ARI.

As noted when training issues were discussed, the construction of new, secure facilities is a major issue which

impacts on the ability of the Army to conduct imagery training. This problem was noted as particularly relevant to training in the Reserve Component.

The need for equipment and systems for collecting, processing, and delivering hardcopy imagery also received considerable attention in the Army Imagery plan. The availability of such assets will directly impact on certain organizational issues as well as impacting on the ability of the imagery interpreter to meet the requirements of combat commanders. The transition from hardcopy to softcopy imagery exploitation and availability of equipment for softcopy exploitation will have similar, but more significant, impacts on organizational and performance issues.

Technical issues related to communications equipment and communication channel capacities are also discussed in the Army Imagery plan. While these issues are clearly engineering issues, communication channel capacities directly impact on the ability to centralize imagery exploitation operations. Centralized imagery processing will require increased communications between the processing center and users of the data in the field. Such technical capability issues must be considered in any research conducted to examine optimal organizational architecture for intelligence operations.

Summary

The issues identified through the literature reviews and interviews with Intelligence SMEs are considerable in number and in the magnitude of their impact on the Army's imagery analysis capabilities. Many of the issues are clearly related to the traditional MANPRINT domains of manpower, personnel, and training. At least within the training area, the intelligence community has already recognized the need for an integrated approach to examining imagery training requirements which are not system specific. At the OSD level, it has been recognized that the manpower requirements in the imagery area must be examined across all of the services in an integrated fashion.

The findings presented above suggest the importance of extending the MANPRINT concept from the single system/unit focus to consideration of MANPRINT issues for an entire functional area such as the IMINT area. The next section of the report presents a brief discussion of a research strategy for extending the MANPRINT concept and addressing critical research issues identified in the IMINT area.

SECTION 4: A RESEARCH STRATEGY FOR THE
IMAGERY INTELLIGENCE AREA

Introduction

This section of the report will present a research strategy for addressing the issues identified in Section 3 of this report. It is important to understand that what is being presented is a strategy for an approach, not a research plan. The translation of the strategy into a research plan will require the identification of appropriate opportunities to achieve the goals identified in the general strategy. These opportunities will be identified over time.

The strategy which is presented is a long-term strategy. The development and implementation of the research program to achieve the ultimate goals identified in the strategy is probably a 5 to 7 year undertaking. At the end of this section a number of short-term projects will be discussed which would provide products and benefits in the near term and create the baseline opportunities and support needed to implement the long-term program.

Research Strategy

The research strategy presented below is a preliminary strategy which will require refinement over time. A major effort should be made to solicit input from key players in the IMINT area during the refinement of the strategy. The discussion of the research strategy will be presented in six sections: objectives; approach; methods; products; applications; and short-term projects.

Objectives

The first task to be accomplished in development of a research strategy in the IMINT area is to clearly articulate the long-term objectives of the ARI research program. The objectives must be more specific than simply to state that the goal is to improve the capability of the Army to effectively support operational requirements for IMINT. The literature reviews and interviews with SMEs suggest that the objectives listed below may represent appropriate goals for the program:

1. Development of a requirements analysis methodology which can be applied to identify IMINT requirements in terms of information needs for operational planning and battle management.

2. Development of a performance model of the imagery analysis process which can serve as the basis for structuring analytic tools and performance measurement instruments.

3. Refinement and extension of the MANPRINT concept from its current focus on single systems/unit to the level of assessment of MANPRINT issues for a functional area.

4. Development of a family of MANPRINT analytic tools for the IMINT Area which would allow assessment of projected requirements and performance impacts of manpower, personnel, and training factors.

Approach

The general approach used in the proposed research strategy includes the accomplishment of several key tasks, some of which can be conducted in parallel and some of which require sequential activities. The tasks are interrelated and mutually supportive. A piece-meal implementation of the strategy is unlikely to result in accomplishment of the objectives stated above. Figure 1 provides a schematic overview of the key tasks included in the strategy.

The first task to be accomplished in the research strategy is to determine the identity of the end users of the products developed in the research programs. Within the current effort, at least three potential end users were identified, ACSI, OSD, and the Intelligence Center at Ft. Huachuca. The MANPRINT-related requirements for each of the end users must be clearly identified. This is a critical task which will require considerable effort. Key players within each organization must be identified. Once the key players have been identified one must work with these individuals to help them articulate the types of products which would be beneficial to them. For example, OSD has voiced an interest in MANPRINT if it can be applied at the functional area level. It may be that what OSD really wants is a manpower planning system which can be applied across the services to assess future manpower requirements. The researcher must identify the underlying need and the nature of the information required. In the case of OSD, the data which is required will likely be used in planning and defending budgets to be presented to Congress. Therefore, a set of analytic tools which could be used to assess impacts of various manpower levels on projected performance as well as projecting manpower requirements would probably be extremely useful.

The input of potential end users must then be integrated with the research objectives of ARI. The point to be noted is that it takes some time and effort to clearly identify the underlying requirements of potential end users. However,
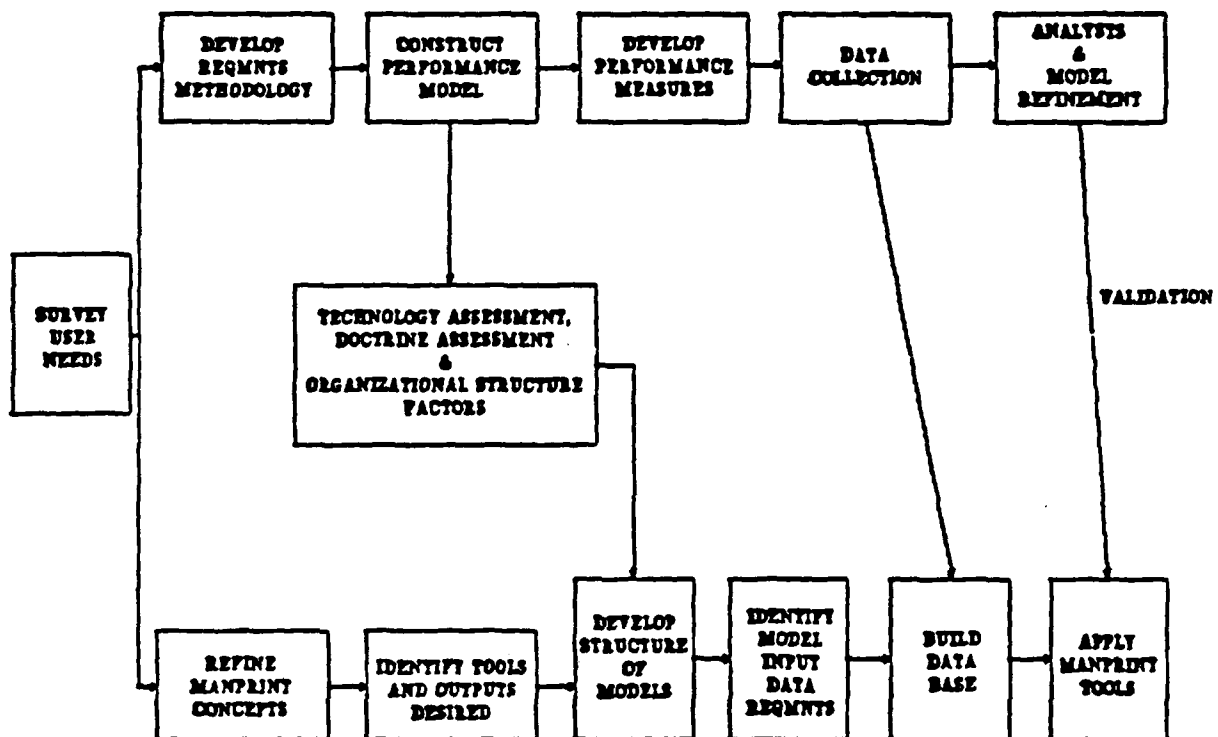
Figure 1. Research strategy.

failure to complete this task will probably result in development of a research program which lacks user support and develops products which will have limited utilization in the intelligence community.

The potential research issues identified through the literature reviews and interviews with SMEs represent a starting point for identification of user requirements. This information should be used as the point of departure for discussions with end users. The goal of the discussions should be to more clearly identify the specific issues of interest to each end user and to develop a mutual understanding of the key factors and objectives related to the issues of interest to the user.

The data collected through the survey of end user needs should be used to refine the initial objectives stated above. More importantly, the information should be used to identify specific products which are to be developed in the research program. After the research objectives and potential end user products for the research program have been clearly articulated, at least two parallel research efforts can be started. The first of these two research efforts will be the refinement and extension of current MANPRINT concepts and analytic tools. The degree to which this effort is made specific to the Intelligence area or event to the IMINT area is a policy decision which must be made by ARI. The current authors would suggest that a fairly generic set of concepts and tools can be developed and tailored to the intelligence area. Thus, Figure 1 illustrates a general refinement and extension of MANPRINT concepts to the functional area level. The tailoring of these concepts to the intelligence or IMINT area will occur through the assessment of emerging technology which will affect these areas and the development of specific analytic tools to be used in MANPRINT analyses in the intelligence area.

As noted in Figure 1, the MANPRINT refinement research program includes a number of subtasks which eventually result in the development of a set of MANPRINT analysis tools. These tools are likely to be an integrated set of computer-based models which are user friendly and can be used by various management and systems analysts in support of the intelligence community's MANPRINT demands. Development of the tools will required identification of the desired output capabilities, development of model structures, identification of input data required, and probably the development of certain initial databases used to calibrate the models. The development of a set of operational tools to be delivered to the user community will require a phased approach to translation of models developed to examine MANPRINT concepts to a user friendly set of programs with clear documentation on their use. The phases include the development of prototype software systems and pilot testing with selected end users.

An assumption underlying the current authors' view of MANPRINT is that MANPRINT factors must be examined within the context of the "total system". What is meant by this statement is that one must consider MANPRINT factors as they impact on the ability of a specified organizational system to accomplish its mission. The organizational system must be defined so as to include relevant equipment, people, applicable doctrine, SOPs, etc. For this reason, the second research effort included in the current research strategy is a program designed to develop an IMINT performance measurement system. As can be noted from *Figure 1* this is essentially a three phase research program which provides input into the MANPRINT tool development program.

The first phase in the imagery performance measurement program is the development of a requirements analysis methodology. When used in this context, the requirements methodology, may be viewed as a means for defining the IMINT mission at different organizational levels. The methodology must enable the research team to translate information requirements of operations organizations and personnel into mission requirements for intelligence organizations and personnel. The application of this methodology will supply data that is essential for the development and application of MANPRINT tools designed to assess manpower, personnel, and training requirements. The MANPRINT tools will translate mission requirements into workloads which can be related to manpower and personnel requirements.

The requirements analysis methodology will probably focus on identification of information requirements for operational planning and battle management at different organizational levels. The development of the methodology will require interviews, surveys, and data collection during training exercises. The methodology itself will require refinement over time; however, it should continue to provide a template for the basic assessment of imagery data requirements of the operational organizations within the Army.

Following development of the requirements methodology, it should be applied to define the mission requirements for military intelligence organizations and personnel processing IMINT. The mission requirements will be the starting point for the development of a performance model of the imagery analysis process. The performance model should include output/criterion measures to assess effectiveness of mission performance as well as individual, organizational, and environmental/system factors which contribute to the effective mission performance.

The performance model will provide the basis for development of criterion measurement instruments. The model also suggests individual, organizational, and environmental/ system factors which should be measured to provide data for feedback to the

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military intelligence units. The development of the performance measures represents the third major step in this research program.

Following the development and refinement of the measurement instruments, the measures should be used to collect data during field training exercises. In addition to serving as the basis for training feedback, the data can be used as input data to calibrate and/or refine some of the models developed as MANPRINT tools. The data collected over time will also serve as the basis for refinement of the performance model developed earlier in this portion of the research program.

As noted in Figure 1, there are a number of important linkages between the MANPRINT tool development and performance measurement development research programs. The performance model provides important information for the development of technology, doctrine, and organizational structure assessment modules which will be included in the family of MANPRINT policy analysis tools. The data collected using the performance measures can be used to calibrate some of the MANPRINT models and may provide the basis for validation of some of the models' output. Likewise, repeated runs of the MANPRINT models may suggest refinements to the military intelligence performance model developed in the performance measurement program.

Research Methods

Implementation of the research strategy described above will require application of a variety of methodologies by an interdisciplinary research team. The team will probably require members with functional area expertise in IMINT, behavioral science, operations research, mathematical modeling, and software development.

The behavioral science methodologies to be applied in the research programs described above include field interviews, surveys, observations during training exercises, task and job analysis, and application of a variety of statistical analysis techniques. These methodologies will be employed most intensely in the development of the requirements analysis methodology and performance model and performance measures. Once the measures have been developed, the data collection will follow standard field data collection procedures.

The survey of end-user needs which is the first step in the proposed research strategy will require field interviews and possibly the development of a field survey. The field interviews should be content analyzed to serve as the basis for development of the survey. Adequate data may be gathered from the interviews to avoid the need for the survey.

The development of the IMINT requirements methodology and the performance model will require literature reviews, field interviews, observations of training exercises, and application of a variety of job analysis procedures. The application of these methodologies will be an iterative process which should begin with review of existing research literature and relevant doctrinal material. Following the literature reviews, field data collection should begin with interviews of operations and intelligence personnel. The interviews should be followed by observations and possibly surveys with larger numbers of operational and intelligence personnel. The development of the requirements methodology and the performance model will require application of a variety of job analysis techniques including SME interviews, observations, etc.

The development of the family of MANPRINT analysis tools will require applications of operations research and mathematic modeling methodologies. Input produced by the application of the behavioral science methodologies will serve as input data in the development and refinement of the mathematical models.

Products

The research programs described above will result in the development of three types of products. The first of these product groups will be performance measurement and feedback systems. The performance measurement instruments will have applications for training and evaluation purposes. When used for training purposes, the performance measures will produce input data for diagnostic feedback systems while the criterion measures provide an indication of bottom line performance. Some of the performance measures may be automated and included as an integrated part of computer simulations.

The second major product produced in the research program will be the requirements analysis methodology. This methodology will have a variety of applications in the analysis and documentation of IMINT requirements over time. The requirements analysis methodology will provide data which can be inputted into the MANPRINT analysis tools to determine manpower, personnel, and training requirements. The requirements methodology may be particularly useful in the MAA process. The methodology will be a primary means of providing data to assess the impact of changes in operational doctrine on the mission of IMINT personnel.

The final set of products developed in the research program will be a family of user-friendly MANPRINT models designed for microcomputers. The models will serve as tools tailored to the needs identified in the user survey. The authors believe that a variety of MANPRINT models will be required to provide the

information needed by decision makers at different organizational levels in the intelligence area. The output of the models at one organizational level may be used as input data for other models. Acceptance and utilization of the MANPRINT tools will be enhanced by clearly documented procedures for using individual models as well as explanations for integrating output from different models.

Based on previous research and experience in the MANPRINT and modeling areas, it seems reasonable to expect that the family of MANPRINT tools will have the greatest utility in assessing manpower, personnel, and training factors. Tools to aid in manpower projection and planning are likely to be the first group of products completed. Eventually, a family of policy analysis products which can be used to assess the impact of new technology, changes in doctrine, and the impact of new force structures on performance will be developed.

Research Applications

Section 3 of the report reviewed a number of potential research issues which might be examined in the IMINT area. The long-term research strategy described above will allow ARI to address many of these issues. Obviously, the development of a requirements analysis methodology will provide the basis for examining the entire category of requirements analysis research issues described in Section 3.

The development of the IMINT performance model and the MANPRINT analysis tools will provide the basis for addressing many of the manpower, personnel, and organizational research issues identified in the literature reviews and the SME interviews. The personnel and manpower projections provided by the MANPRINT models can be verified overtime through collection of performance data during major training exercises. The MANPRINT analysis tools will provide data regarding projections of future training requirements resulting from introduction of new technology and changes in doctrine. The evaluation of training effectiveness will depend largely upon the data collected using the criterion and performance measures during major training exercises. The performance data provided by the criterion measures will also be required in research studies designed to examine various human factors variables such as the impact of various shift lengths for imagery interpreters working on softcopy.

Short-Term Research Projects and Products

The research strategy and products described above reflect a long-term orientation. The authors recognize that the

development and implementation of such an applied research program will require the cooperation of a variety of intelligence organizations who have immediate needs for technical and research support. It will be possible to provide these agencies with certain types of research support while simultaneously progressing toward long-range research objectives. The qualification which must be placed upon such research projects is that they often provide only a "40 or 50%" solution which would not withstand the rigorous critique applied to many "pure" research efforts. On the other hand, a "40 or 50%" solution in areas such as performance measurement often provide data whose accuracy or utility are orders of magnitude greater than existing data.

Examination of the potential research issues in Section 3 and previous experience in the applied research and intelligence areas suggest several areas in which short-term research might provide benefits to the intelligence community. Several of these research areas are briefly described below.

Embedded Training and Job Aids. The Army Imagery plan identified serious training problems resulting from the fielding of a wide variety of systems. The application of existing knowledge concerning the development of embedded training and automated job aids may be a partial short-term solution to this problem. While ARI is certainly not in the software development business, the Training Laboratory could probably provide some technical assistance to initiate the development of job-aids and/or embedded training on selected systems entering the field. The intelligence area may even provide a potential test-bed for long-term research in the embedded training area.

Manpower, Personnel, and Training (MPT). Section 3 identifies a number of critical research issues related to the MPT areas. In the short-term, technical assistance in the design and implementation of data collection plans in major imagery field exercises may be the greatest benefit which can be provided to the intelligence community. The focus should probably be on identifying operational requirements for imagery data and factors impacting on the processing and output of the imagery exploitation process. Documentation of the time required to perform various activities is critical baseline data which will be required for the long-term research program.

Specific technical assistance which could be provided for the data collection efforts include the development of observation guides for observers, conducting observer training, and assistance in data collection and analysis. All of these efforts will provide direct benefits to the long-term research program. Of benefit to the intelligence community will be a limited amount of quantitative data and a wealth of systematically collected qualitative data regarding task

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requirements and potential training deficiencies. Such data is
of particular importance in the development of a generic imagery
training program and projection of future training requirements.

The performance and task requirements data collected in the
field training exercise may also be useful in the short term for
those agencies concerned with manpower planning. A number of
models are currently in developmental stages which may be
modified to examine manpower projections. Baseline performance
data, time required to complete essential mission tasks, and
workload requirements are the types of data required as input in
the models. It may be possible to conduct preliminary analysis
of data collected in major field training exercises with
experimental equipment to develop some projections of manpower
requirements for fielding the systems. More importantly, the
data will allow the modification of existing models which could
then be applied to selected systems in very early stages of
development to project manpower impacts.

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APPENDIX

POTENTIAL RESEARCH ISSUES

MANPOWER AND PERSONNEL

1. Need for increased imagery interpreters in corps support elements.

2. Additional skill indicators required to identify and manger personnel qualified n new systems.

3. Need for accurate projects of manpower requirements of new systems being field across Services (OSD level manpower p- lanning).

4. Changes required in imagery manpower allocations across organizational levels as a result of changes in operational doctrine.

5. Changes in cognitive and information process skills for imagery interpreters required in transition from hardcopy to softcopy exploitation.

6. Potential changes in MOS structure resulting from fielding of new "high tech"/ "state-of-the-art" systems.

TRAINING

1. Increased training burden from from new imagery systems being fielded.

2. Ineffectiveness of on-the-job training for new systems due to lack of expertise in the field.

3. Embedded training aid or on-line job aids as a substitute or supplement to system specific training

4. Changes in training requirements resulting from changes in doctrine.

5. Increasing gap in readiness between active and reserve components resulting from limited training opportunities for the reserve component.

6. Need for realistic training simulations which can be field for both active and reserve component training.

7. Design and evaluation of generic imagery training (Full Spectrum Imagery Training, FSIT)

8. Potential changes in approach to training as a result in cognitive/information processing skills needed for new imagery interpretation systems.

HUMAN FACTORS/ HEALTH HAZARDS

1. Need to examine the optimal and maximum shift length for effective performance of imagery interpreters using softcopy exploitation systems.

2. Impact of stress factors (physical and cognitive) on imagery interpreter performance.

3. Evaluation of physical demands (visual) of extended use of softcopy exploitation systems.

4. Environmental design factors which might enhance softcopy imagery interpretation performance.

ORGANIZATIONAL STRUCTURE

1. Optimal degree of centralization of IMINT assets (equipment and personnel).

2. Organizational level at which centralization of IMINT processing should occur.

3. Impact of changes in operational doctrine on optimal organization of imagery processing support organizations (CEWI) at the division and corps levels.

4. Need for reorganization of selected reserve component organizations.

5. Optimal organization of the collection management process including the organizational level at which various collection assets are controlled. (Particularly important with regard to requirements for corps-level management of deep battle operations.)

REQUIREMENTS ANALYSIS METHODOLOGY

1. Need for development of methodology to assess functional imagery exploitation requirements to support operational planning and battle management at various organizational levels.

2. Application methodology to assess variation in timeliness, quality, and quantity of imagery data required during different phases of corps level operations.

SAMPLE ENGINEERING AND FACILITY ISSUES

1. Impact of limited compartmentalized facilities on training capabilities.

2. Need for additional hardcopy collection, processing, and delivery systems.

3. Technical issues related to communications capabilities which impact on feasibility of centralizing imagery processing operations.